

UNIVERSITY OF CALGARY
DEPARTMENT OF PHYSICS and ASTRONOMY
COURSE OUTLINE

1. Course: **Physics 611, Statistical Physics**

Lecture Sections:

L01: TuTh, 14:00-15:15, ST 055

Instructor: Dr. J. Davidsen

Office: SB 505, 403-210-7964

Office Hours: Tu 15:30 – 16:30

Email: joern.davidsen@ucalgary.ca

Physics and Astronomy Office: SB 605, 403-220-5385

2. **PREREQUISITES:** It is expected that a student's background will include Physics 449 or equivalent.

3. **GRADING:** The University policy on grading and related matters is described sections F.1 and F.2 of the online University Calendar. In determining the overall grade in the course the following weights will be used:

| | |
|-------------------|--|
| Assignments | 35% |
| Midterm test | 25% (Tu March 8, in-class) |
| Final Examination | 40% (To be scheduled by the Registrar) |

Percentage grades will be given for all elements of term work and examinations in Physics 611. A weighted course percentage will be calculated for each student after the final exam is written. A table of conversion from final course percentage to final course letter grade will be published on the Phys 611 Blackboard site later in the term.

4. **Missed Components of Term Work.** The regulations of the Faculty of Science pertaining to this matter are found in the Faculty of Science area of the Calendar in section 3.6: <http://www.ucalgary.ca/pubs/calendar/current/sc-3-6.html>. It is the student's responsibility to familiarize himself/herself with these regulations. See also <http://www.ucalgary.ca/pubs/calendar/current/e-3.html>.

Assignments: Assignments must be handed in on time. Late assignments will not be marked, unless circumstances such as illness prevent a student from meeting the deadline.

6. **TEXTBOOK:** "*Statistical Physics of Particles*", Mehran Kardar, Cambridge University Press

7. **EXAMINATION POLICY:** All exams are closed book exams, no calculators are permitted. Students are encouraged to read the Calendar, Section G, on Examinations: <http://www.ucalgary.ca/pubs/calendar/current/g.html>.

Department Approval _____ Date _____

Associate Dean's Approval for out of regular class-time activity: _____ Date: _____

11. OTHER IMPORTANT INFORMATION FOR STUDENTS:

(a) **ACADEMIC MISCONDUCT** (cheating, plagiarism, or any other form) is a very serious offence that will be dealt with rigorously in all cases. A single offence may lead to disciplinary probation or suspension or expulsion. The Faculty of Science follows a zero tolerance policy regarding dishonesty. Please read the sections of the University Calendar under K. Student Misconduct (<http://www.ucalgary.ca/pubs/calendar/current/k.html>) to inform yourself of definitions, processes and penalties

(b) **ASSEMBLY POINTS in case of emergency during class time.** Be sure to FAMILIARIZE YOURSELF with the information at <http://www.ucalgary.ca/emergencyplan/assemblypoints>.

(c) **ACADEMIC ACCOMMODATION POLICY.** Students with documentable disabilities are referred to the following links:
Calendar entry on students with disabilities: <http://www.ucalgary.ca/pubs/calendar/current/b-1.html>
Disability Resource Centre: <http://www.ucalgary.ca/drc/>

(d) **SAFEWALK:** Campus Security will escort individuals day or night (<http://www.ucalgary.ca/security/safewalk/>). Call 220-5333

for assistance. Use any campus phone, emergency phone or the yellow phones located at most parking lot pay booths.

- (e) **FREEDOM OF INFORMATION AND PRIVACY:** This course will be conducted in accordance with the Freedom of Information and Protection of Privacy Act (FOIPP). As one consequence, **students should identify themselves on all written work by placing their name on the front page and their ID number on each subsequent page.** For more information see also <http://www.ucalgary.ca/secretariat/privacy>.
- (f) **STUDENT UNION INFORMATION:** VP Academic **Phone:** 220-3911 **Email:** suypaca@ucalgary.ca.
SU Faculty Rep. **Phone:** 220-3913 **Email:** sciencerep@su.ucalgary.ca Website <http://www.su.ucalgary.ca/home/contact.html>.
Student Ombudsman: <http://www.su.ucalgary.ca/services/student-services/student-rights.html>
- (i) **INTERNET and ELECTRONIC COMMUNICATION DEVICE Information.** You can assume that in all classes that you attend, **your cell phone should be turned off.** Also, communication with other individuals, via laptop computers, Blackberries or other devices connectable to the Internet is not allowed in class time unless specifically permitted by the instructor. If you violate this policy you may be asked to leave the classroom. Repeated abuse may result in a charge of misconduct.

DETAILED COURSE SYLLABUS

Catalog description: Classical and quantum ensemble theory applied to interacting systems: real gases, spin lattices, phase transitions. Kinetic theory: Boltzmann equation, transport processes, irreversible processes and fluctuations.

Specifically, we will cover:

- 1. Probability theory:** random variables, probability distributions, central limit theorem, rules for large numbers, information & entropy, maximum entropy principle
- 2. Kinetic theory:** phase space density, Liouville's theorem, ergodicity & mixing, BBGKY hierarchy, Boltzmann equation, H-theorem & irreversibility
- 3. Classical Statistical Mechanics:** microcanonical ensemble, two-level systems & negative temperature, ideal gas, mixing entropy & Gibbs paradox, canonical ensemble, grand canonical ensemble
- 4. Interacting systems:** cumulant expansion, cluster expansion, van der Waals equation
- 5. Quantum Statistical Mechanics:** dilute polyatomic gas, vibrations of a solid, black body radiation, quantum microstates, quantum macrostates, density matrix, quantum ensembles
- 6. Ideal quantum gas:** identical particles, canonical formulation, grand canonical formulation, non-relativistic gas, degenerate Fermi gas, degenerate Bose gas, Bose-Einstein condensation
- 7. Introduction to phase transitions and critical phenomena** (time permitting): Ising model, transfer matrix method, mean-field theory, Landau theory, Yang-Lee theory

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In addition to our textbook, the following are useful reference books:

1. H.B. Callen. Thermodynamics and an Introduction to Thermostatistics, 2d ed., Wiley (2001). ISBN-10: 0471862568.
2. Morikazu Toda, Ryōgo Kubo, Nobuhiko Saitō: Statistical physics, Springer, 1991. ISBN 3540536620, 9783540536628.
3. Ma, Shang-keng. Statistical Mechanics. Translated by M. K. Fung. Philadelphia, PA: World Scientific, 1985. ISBN: 9971966069 (Singapore).
4. Landau, L. D., and E. M. Lifshitz. Statistical Physics. Part 1. 3rd ed. New York, NY: Pergamon, 1980. ISBN: 0080230385.
5. Reif, Frederick, ed. Fundamentals of Statistical and Thermal Physics. New York, NY: McGraw-Hill, 1965.
6. Stanley, H. Eugene. Introduction to Phase Transitions and Critical Phenomena. New York, NY: Oxford University Press, 1971. ISBN: 0195014588.
7. Reichl, Linda E. A Modern Course in Statistical Physics. 2d ed., Wiley (1998). ISBN-10: 0471595209.
8. Michael Plischke, Birger Bergersen: Equilibrium Statistical Physics, World Scientific, 2005. ISBN 9812560483, 9789812560483.

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Homework assignments will typically be handed out on Tuesdays and are due the following Tuesday before class. All course related material will be posted on Blackboard.

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**Important dates for Winter 2011**

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| M 10-01              | Lectures begin.                        |
| F 21-01              | Drop date deadline                     |
| M 24-01              | Add date deadline                      |
| F 28-01              | Fee payment deadline                   |
| M 21-02              | Alberta Family Day – University Closed |
| Su 20-02 to Su 27-02 | Reading Week                           |
| F 15-04              | Lectures end.                          |
| M 18-04 to F 29-04   | Final Exam period                      |
| F 22-04              | Good Friday – University Closed        |

